THE UNIVERSITY OF BRITISH COLUMBIA
School of Biomedical Engineering
Faculties of Applied Science and Medicine

BMEG 220: Circuits and Electromagnetics with Application to Biomedical Engineering

2025W2 Syllabus

COURSE INFORMATION

Instructor:	Negar Harandi, PhD, P.Eng. (referred to in this file as "I")
Email:	negar.harandi@ubc.ca
Office Hours & Location:	Office hours are online and one-on-one with Dr. Harandi. That's where I typically discuss course content, best studying habits, and mental health support with students. Please book timeslots on Canvas Calendar.
Response Time:	I'll respond to emails in 48 hours – Please include [BMEG 220] in the title. TAs respond to Piazza posts in 48 hours. I will review the responses once weekly before Sunday midnight.
Teaching Assistant Info:	Stellar undergraduate TAs Jessica Xin and Jae-Yoon Kim facilitate Piazza.
Pre-Requisites:	PHYS 158 or PHYS 118, MATH 253.
Co-Requisites:	MATH 264 Section 203, MATH 256.

LECTURE DATES | TIMES | ROOMS

Lecture:	Mondays 2-4 PM (including MATH 264); Tuesdays, Thursdays, and Fridays 2-3 PM
Tutorial:	Every other Wednesday, starting from Week two, 2-4 PM. Check the exact dates of the quizzes, midterm and review sessions on Canvas.

All sessions are scheduled in SHRM B1001.

ABOUT YOUR INSTRUCTOR

I grew up in Tehran, Iran's busy capital city in the West Asia. In high school, I fell in love with Physics and Math, which led me to earn a bachelor's and master's degree in electrical engineering. I was privileged to have a family that supported my education, and to have access to free public schools. It was 15 years ago when I moved to Vancouver to study at UBC. During my PhD, I focused on biomechanical modeling and simulation of the oral region and airway for speech production. Later, during my postdoctoral fellowship in engineering education I discovered my interest in understanding the science behind teaching and learning. Now, UBC feels like home, I look forward every day to connect with students, and I'm grateful to work at SBME as an assistant professor of teaching.

COURSE DESCRIPTION

Electromagnetic force is one of the four fundamental interactions in physics. It keeps the mater together and governs all chemical reactions in nature. Quantifying the effects of this force on different materials has enabled us to use it to our advantage. Today we convert, transfer, store and consume energy base on principles of electromagnetism.

In this course, we will discuss the core knowledge required to analyze electrical components of the physiological and biomedical systems. Using vector calculus as a powerful tool, we will tackle analysis of electric and magnetic fields, and their interdependency through Maxwell equations. We will also learn how to analyze and build electric circuits applicable to instrumentation of medical devices.

LEARNING OBJECTIVES

By the end of this course, you'll be able to …

- Solve for the force on charged structures in the presence of electric fields
- Solve for the electric field at a point due to a variety of charge distributions
- Find the electric field given the electric potential, and vice versa
- Apply Coulomb's and Gauss' law to find the electric field resulting from charge distributions
- Apply nodal and mesh analysis to solve for currents and voltages in lumped planar circuits
- Apply Norton and Thevenin's theorems to find resistive equivalents of circuits
- Use boundary conditions to determine the effect of different materials on EM fields
- Evaluate the resistance, capacitance or inductance of a variety of structures
- Analyze circuits including ideal and non-ideal operational amplifiers
- Analyze the transient response of RC, RL and RLC circuits
- Apply Biot-Savart Ampere's law to find the magnetic field resulting from current distributions
- Describe the different types of magnetic materials
- Use complex numbers and phasor algebra to find steady state sinusoidal response of AC circuits
- Characterize AC filters based on their frequency response
- Analyze the behavior of conducting structures in the presence of a time-varying magnetic field
- Explain and apply Maxwell's equations

COURSE ORGANIZATION / STRUCTURE

We'll have five class hours per week, and one biweekly 2-h tutorial session. Tutorial sessions will be used for reviewing the material as well as quizzes and the midterm.

The course topics can be divided into two sections: electromagnetics (including electrostatics and magnetostatics) and circuit analysis. We will study both sections in parallel throughout the semester.

This course is also thoroughly integrated with MATH 264 section 203. MATH 264 content will account for about an extra hour per week over the semester, but the exact distribution and schedule will vary from week to week. The schedule of topics will be posted on Canvas modules – please refer to Canvas during the course for up-to-date information.

STUDENT EVALUATION

The course assessments focus on your ability to understand, strategize, and solve problems in electromagnetics and circuits. There will be two quizzes, a midterm, and a final exam. The final will be held during the April 14–25 exam period, while the other tests are during Wednesday tutorials. If UBC requires online testing, invigilation may involve using your webcam and microphone. **To pass, you must score over 50% of the weighted sum of the final exam, midterm, and quizzes.**

Assignments include weekly homework and pre-class activities. Homework is released on WeBWorK every Monday and is typically due the following Monday at midnight. Links to assignments and pre-class activities are in the Canvas weekly modules. You are encouraged to discuss challenging problems with classmates but complete your individual problems independently. Please use Piazza to ask and answer homework questions but **avoid posting complete solutions—focus on helpful ideas instead**.

Active participation marks are awarded for completing in-class activities and feedback tasks, such as time trackers, exam wrappers, and the midterm survey. Bonus marks are available for meaningful contributions to Piazza discussions.

MATH 264 Mastery-Based Assessment:

BMEG 220 and MATH 264 are fully integrated; failure in one will result in failure in the other, and both courses will share the same final grade. Twenty (20) percent of your exam grade is based on solving math problems during tutorials (Review II, III, Quiz I, II, Midterm) and the final exam. Each problem aligns with specific learning objectives, which are clearly identified. Grades for this portion are calculated based on the percentage of objectives you have “mastered” (see Canvas for weights).

To simplify grading, solutions are graded as either "Mastered" for nearly perfect solutions or "Failed" for progressing or incomplete work. To pass MATH 264, you **must achieve mastery in 8 out of 16 math learning objectives**. No partial credit is given for Progressing or Beginning scores.

You may retake assessments for learning objectives in future tests. If you achieve “mastery” on a competency test, you won’t need to reattempt related questions later. The math portion of the final exam will include the last learning objective and retakes for earlier objectives. **The last learning objective will be tested only on the final, with no retake option.**

EVALUATION GROUP	EVALUATION METHOD	PERCENTAGE OF FINAL GRADE
TESTS	Final Exam	%36
(60% OUT OF 80%)	Quizzes and Midterm	%24
ASSIGNMENTS	WW Assignments	%9.5
(12% OUT OF 80*)	Pre-class WW	%2.5
PARTICIPATION	Active Class Participation	%8
(10% OUT OF 80%)	Course Feedback	%1
	Piazza Participation	%1
	TOTAL	**82%**

COURSE MATERIALS

The following textbooks are available electronically, free or through UBC library.

- Elements of Electromagnetics – Sadiku, Nelatury. 2018. *Noted as "EE" in the course schedule table below.*
- Circuit Analysis & Design - Ulaby, Maharbiz and Furse. 2018. *Noted as "CAD" in the course schedule table below.*
- Engineering Electromagnetics - Ida. 2015. *Not noted directly in the course schedule below but can be used in conjunction with EE above.*

COURSE SCHEDULE

Here is a rough list of weekly topics thought in the course. The exact and detailed schedule is on Canvas.

Week	Topic	Textbook Section
1	Introduction and Course Policies. EM: Coulomb's law Circuit: Resistor combinations, KVL and KCL	EE – 2.1 to 2.4, 4.1 to 4.3 CAD – 1, 2.1 to 2.3
2	EM: Work and Potential Circuit: Mesh and Nodal Analysis	EE – 4.7, 4.8 CAD – 3.1 to 3.3
3	EM: Potential and Gauss Law Circuit: Circuit Analysis, Source Transformation	EE – 4.5, 4.8 CAD - 3.4, 3.5
4	EM: Flux integral Circuit: Thevenin Equivalent	EE – 4.4 CAD – 3.6
5	EM: Current Circuit: Norton Equivalent	EE – 5.1 to 5.3 CAD – 3.6, 3.8
6	EM: Resistance Circuit: More on Thevenin/Norton, Opamps	EE – 5.4, 6.5 CAD – 4.1 to 4.3
7	EM: Boundary Conditions and Capacitors Circuit: Opamps	EE – 5.6, 5.9, 6.5 CAD – 4.4 to 4.6
8	EM: Biot-Savart Law Circuit: Transient Responses - RC and RL Circuits	EE – 7.1, 7.2 CAD – 5.1 to 5.5
9	EM: ACL Circuit: Transient Responses - RLC Circuits	EE – 7.3, 7.4 CAD – 6.1 to 6.7
10	EM: Magnetic Flux, Stokes Theorem and Magnetic Forces Circuit: Phasor Calculus	EE – 7.5, 8.1, 8.2 CAD – 7.1, 7.2
11	EM: Magnetic Torque, Materials and Boundary Conditions, Circuit: Introduction to AC circuits, Impedance, AC Power	EE – 8.3 to 8.7 CAD –7.3 to 7.6, 8.1, 8.2
12	EM: Inductance, Faraday's Law Circuit: Frequency Response	EE – 8.8, 8.9, 9.1, 9.2 CAD – 9.1 to 9.3
13	EM: Maxwell's Equations Circuit: Passive Filters	EE – 9.5 CAD – 9.3, 9.4

ONLINE ETTIQUETTE

Please adhere to the rules highlighted below on the Piazza discussion board:

- **NO PROFANITY or DEROGATORY TERMS** Everyone in the class and your instructional team can see course discussion boards. Please be polite and professional in your messaging.
- **AVOID POSTING COMPLETE ANSWERS** When posting the answers, refrain from solving the problem completely, instead, point out relevant ideas from the course.
- **RESPECTFUL ENVIRONMENT** As per the UBC statement on Respectful Environment, disrespectful behaviour will not be tolerated. Do your part to ensure that everyone feels comfortable using the discussion board as a resource.
- **RELEVENCE** Post questions and answers about homework - and other parts of the course - which are of general interest.
- **SEARCH BEFORE POSTING** Review all the posts and answers before posting a new thread**.** Often a homework question has been discussed in a different post.
- **TAG YOUR POST** Use the right tag to identify your questions and notes.

TECHNOLOGY REQUIREMENTS

In case UBC requires tests to be carried online, you will require a means of scanning and uploading written work during the tests. This could be either a scanner or a phone app. For information on using your phone as a scanner, please refer to the Scanning Guide document on Canvas. You should also be prepared to have a webcam and microphone available in the event that online invigilation is used for assessment activities.

ATTENDANCE AND LATE POLICY

Attending lectures is highly recommended but will not be enforced. Students not attending a session will miss the participation grade of that session. In case of missed sessions, your grade might be adjusted, **only if** (1) you have a course conflict previously discussed with your instructor, or (2) you have an emergency (on medical or compassionate grounds) that you have communicated **beforehand** to your instructor. All assignments must be submitted before the due date and time. Late submissions will receive zero mark.

DIVERSITY AND INCLUSION STATEMENT AND POLICIES

In an ideal world, applied science would be objective. However, much of applied science is subjective and is historically built on a small subset of privileged voices, mostly of white men. This document (shared through UBC APSC EDI Committee) summarizes responses to 10 common criticisms to anti-racism work in STEM and could be a good resource for keeping faculty and students on track of the work it needs to be done to make our engineering discipline more diverse and inclusive. I (like many people) am still in the process of learning about diverse perspectives and identities as they relate to the field of Biomedical engineering. In this course, I strive to create a learning environment that supports a diversity of backgrounds, perspectives, and experiences, and honors your identities (including race, gender, class, sexuality, religion, ability, etc.) To help accomplish this:

- If you have a name and/or set of pronouns that you prefer me to use, please let me know.
- If you are registered with Center for Accessibility and require academic accommodations for test writing, please let me know by email. Use the title “Accessibility for BMEG 220”. **Make sure to register your assessments with the Centre, at least two weeks in advance.**

- If you feel like your performance in the class is being impacted by your experiences outside of class – including but not limited to your family/friend dynamics, interaction with your peers or instructors, financial and/or mental health challenges – please don't hesitate to book a one-on-one office hour to talk with me. I want to be a resource for you. Remember that you can also submit anonymous feedback on Piazza, which I would consider as seriously. If you prefer to speak with someone outside of the course, Kelly White, Senior Manager of Academic and Special Programming, is an excellent resource.

UBC POLICY ACADEMIC INTEGRITY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences. For more information, see:

http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0

ACADEMIC CONCESSION

The University is committed to supporting students in their academic pursuits. Students may request academic concession in circumstances that may adversely affect their attendance or performance in a course or program. Students who intend to, or who as a result of circumstance must, request academic concession must notify their instructor, dean, or director as specified in the link below. http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,48,0,0.

For online reporting of in term concessions please consult the following form:
https://academicservices.engineering.ubc.ca/form-request-for-academic-concession-in-term-work/

To minimize the need for in term concessions, your final grade will account only for best N-2 of N pre-class, in-class and weekly assignments.

Students seeking academic concession due to absence from the final exam for any reason must apply to Engineering Student Services (ESS) within 72 hours of the missed exam. This is a standard practice for all final examinations at UBC.

For more information, see: http://students.engineering.ubc.ca/enrolment/faq/

LEARNING ANALYTICS

This course will be using the following learning technologies: Canvas, Piazza, WeBWorK, and perhaps others as needed. Many of these tools capture data about your activity and provide information that can be used to improve the quality of teaching and learning. In this course, we may use analytics data to:

- View overall class progress

- Track your progress in order, e.g., to provide you with feedback or advice
- Review statistics on course content being accessed to support improvements in the course
- Track participation in discussion forums
- Assess your participation in the course

COPYRIGHT

All materials of this course (course handouts, notes, assignments, assessments, readings, recordings, etc.) are either copyright of the Course Instructor or licensed to be used in this course by the copyright holder. **Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline.** Lecture recordings, if provided, are for use in-term by registered students only.

STATEMENT ON UNIVERSITY'S VALUES AND POLICIES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students ae expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all their actions. Details of the policies and how to access support are available here: senate.ubc.ca/policies-resources-support-student-success.

LAND ACKNOWLEDGMENT

This course is held on the UBC Point Grey (Vancouver) campus, which sits on the traditional, ancestral, unceded territory of the Coast Salish Peoples, including the territories of the xwməθkwəy̓əm (Musqueam), Skwxwú7mesh (Squamish), Stó:lō and Səl̓ílwətaʔ/Selilwitulh (Tsleil- Waututh) Nations. The land it is situated on has always been a place of learning for the indigenous people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.